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Reliability of Surgical Margin Labels Using 3D Radiographic Software

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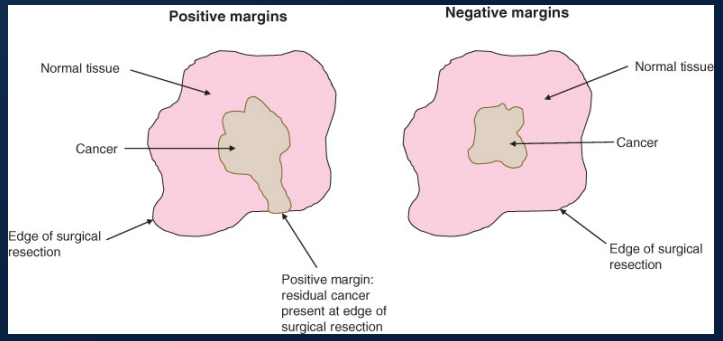
Introduction

- Surgical resection is a primary treatment for head and neck cancers
  - Improves prognosis and quality of life for patients
  - Goal of surgical resection is to remove the tumor and attain a clear surgical margin
    - 5 mm from the edge of the resection
  - Surgical margin status is one of the most important predictors of local recurrence
  - Positive surgical margins have negative clinical implications:
    - Increased mortality rates
    - Adjuvant treatment
    - Indication for margin revision surgery
      - Not associated with improved outcomes
      - May be related to challenges in margin identification



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Introduction

- Surgical Margin Labeling
  - Designated with a text-based label describing the anatomic location
    - May allow for differences in interpretation of the surgical margin origin
  - Lack of consensus on how surgical margins should be labeled for accurate and reliable origin identification
  - Few advances in margin assessment methodology in recent years
    - Potential need for optimization and standardization of surgical margin labeling

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Objectives & Hypothesis

- Research Question
  - Do surgical margin labels in head and neck cancer surgery describe the anatomic origin of surgical margins reliably among head and neck cancer surgeons?

- Research Hypothesis
  - Surgical margin labels do not describe the anatomic origin of surgical margins reliably among head and neck cancer surgeons.
  - Differences in interpretation of surgical margin labels among Thomas Jefferson University head and neck surgeons will result in variability in anatomic relocalization of the surgical margin.

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Approach

- Study Design
  - Nine adults with head and neck cancer who underwent surgical resection
  - Preoperative CT scans were obtained and imported into a modular, multiplanar radiology software (3D Slicer)
  - 3D tumors were segmented
  - Surgical margin labels and margin status were collected from the pathology report
- Subjects
  - Thomas Jefferson University Otolaryngologists

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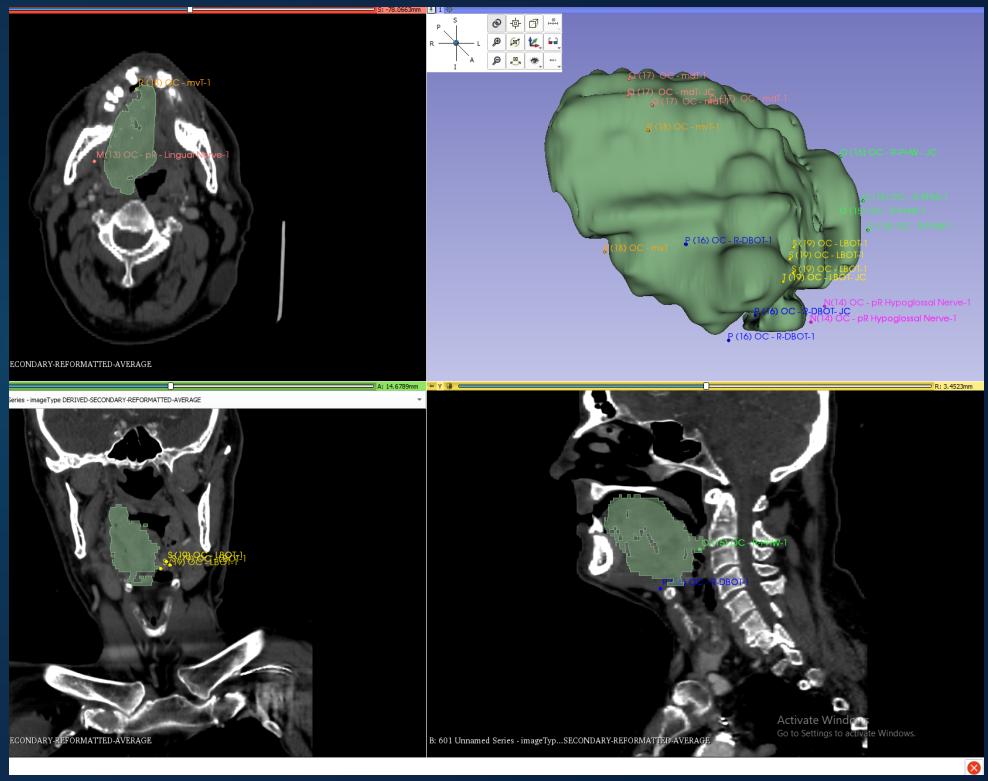
Approach

- Data Collection
  - 3D Slicer
    - Zoom
    - Remote control
  - Surgeons were provided:
    - Description of the surgical case
    - Surgical margin label
  - Surgeons were asked to mark the anatomic location indicated by each surgical margin label on any preferred radiographic plane or directly on the 3D tumor
  - Each mark provided x, y, z coordinates (mm)



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Approach

- Rationale for Approach
  - A modality by which surgeons could provide high resolution data to mark surgical margin anatomic locations in a controlled environment

- Data
  - Seven TJU Otolaryngologists
  - Nine surgical cases
  - 64 surgical margins labels
    - 59 negative margin status
    - 5 positive margin status
  - 336 surgical margin datapoints
    - x, y, z coordinates (mm)

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Approach

- Analysis
  - For each surgical margin label a centroid mean was calculated in the x, y, and z coordinate planes using the respective surgeon responses
    - Surrogate measure of the true margin
  - Calculated the difference between each surgeon's response from the mean in the x , y, and z coordinate planes for each surgical margin label
    - Averaged the distance among all surgeons in the x, y, and z coordinate planes
  - Calculated the three-dimensional distance from the mean for each surgeon's response per surgical margin label
    - Averaged the three-dimensional distance among all surgeons
    - ANOVA
      - Variance
    - Unpaired T-Test
      - Positive surgical margins and negative surgical margins

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Results

- Results
  - Surgeons localized margins with a mean of 5.6 mm, 6.8 mm, 6.7 mm from each margin centroid in the respective x, y, and z coordinate planes
  - In three dimensions, surgeons localized margins with a mean of 12.88 mm from the margin centroid and with high variance (10.9, SD: 3.302, $p<0.001$).
  - Surgical margins positive (PSM) for carcinoma were further from their respective centroid than non-PSMs (PSM 21.02 mm, Non-PSM 12.73 mm, $p<0.01$)

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Conclusions

- Conclusions
  - Surgeons were able to use a modular radiographic software with multiplanar 2D and dynamic 3D functions to independently document surgical margin locations with high-resolution
  - Interpretative variability in surgical margin labels is demonstrated through a lack of concordance

- Clinical Implications
  - Opens community discussion that surgical margin labels may not be an effective way to communicate the location of surgical margins
    - An approach utilizing multimodal technology may provide a more reliable method for identifying the surgical margin anatomic origin
    - An optimized and standardized surgical margin labeling protocol has the potential to improve clinical outcomes for patients with head and neck cancers
      - Potential implications for other malignancies

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Future Directions

- Further data collection
  - TJU pathologists and radiologists

- Prospective Virtual Reality
  - Preoperative surgical planning
  - Postoperative surgical revision
  - Postoperative surgical margin marks
    - Allowed for an accurate identification of the true surgical margin

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Disclosures

- None

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